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Abstract

This Sampling and Analysis Plan (SAP) replaces, and is a revision of, Rocketdyne Engineering Report 173ER000010, “Sampling and Analysis Plan for RIHL D&D Waste.” It describes the strategy and methodology used by DOE Site Restoration for the characterization of radioactive waste by sampling and analysis. The plan applies to those wastes that can be characterized by analysis, and thus do not fall under the guidelines for characterization by process knowledge alone. This document provides the site description, organization and responsibilities, data quality objectives, and the sample selection and analysis approach for compliance with Nevada Test Site (NTS) waste acceptance criteria. The plan is also applicable to wastes to be qualified for shipment to an alternative disposal site. Detailed sampling and analysis procedures will be prepared, in conformance with this SAP, for each of the waste streams to which sampling and analysis requirements are applicable.

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Supporting Document Summary of Change

No. EID-04487
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Rev.	Summary of Change	Approvals and Date
A.1	(Section 3.8) Removed discussion of chelating agents associated with the former Hot Laboratory, as no longer relevant.	R. A. Marshall R. Amar S. E. Reeder P. D. Rutherford B. D. Sujata
A.2	(Section 4.3) Removed "(at least annual)" from statement of audit requirements for consistency with the requirements of Boeing Canoga Park Standard Operating Procedure 6.0.	
A.3	(Section 4.2.5) Removed formal documentation of percentage of completion of validated analytical data.	
B.1	(Section 2) Moved non-nuclear environmental compliance technical support responsibility from Environmental Remediation to DOE Site Restoration	R. A. Marshall R. Amar S. E. Reeder P. D. Rutherford B. D. Sujata
B.2	(Section 2) Updated Rocketdyne organization chart	
B.3	(Section 3 & References) Updated DOE Order 5820.2A to 435.1	
B.4	(Section 4) Added Data Quality Objectives	
B.5	(Section 6.1) Changed EPA volatile organic analysis method from 8240 to 8260	
B.6	(Section 6.2) Added ^{63}Ni, ^{55}Fe analysis method to Table 5	
B.7	(Section 8) Revised data validation and reporting sections; added sampling data summary and validation report formats with prescriptive requirements	
C.1	(Section 8.1) Added statement on propagation of error (per NTS requirements)	R. A. Marshall R. Amar D. L. Koncel P. D. Rutherford
C.2	(Section 8.2) Added statement on third-party review requirements for waste to be sent to NTS	

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1.0 PROGRAM DESCRIPTION

This sampling and analysis plan (SAP) sets forth the protocol for the sampling and analysis of containerized waste generated during the environmental remediation of Area IV of Boeing Canoga Park's Santa Susana Field Laboratory (SSFL). Detailed sampling procedures for each containerized waste stream shall be based on this SAP, and sample analyses shall conform to the data quality assurance objectives outlined in this document. The purpose of this document is to assure waste stream compliance with the waste acceptance criteria of the Nevada Test Site (NTS) and other approved disposal sites, as set out for example in Ref. 1, "Nevada Test Site Waste Acceptance Criteria" (NTSWAC).

1.1 SITE DESCRIPTION

The Santa Susana Field Laboratory is located in the Santa Susana Mountains, approximately six miles west-northwest of Canoga Park, California. It is owned by the Canoga Park (Rocketdyne) Division of The Boeing Company. The laboratory has been used for rocket engine testing and energy research since the 1950s. Area IV comprises 270 acres at the northwest portion of the 2849-acre site, where nuclear energy research was performed at twenty-five facilities. This area includes the 90-acre site of the former Energy Technology Engineering Center (ETEC), operated by Boeing Canoga Park for the Department of Energy (DOE). All nuclear work ended in 1988, and the decontamination and decommissioning (D&D) of the area have been ongoing since that time. ETEC ceased to be a DOE operating laboratory in December 1998 and is planned for site closure in September 2006. At that time, the DOE-occupied land will be released to Boeing.

Initial waste shipments to the Nevada Test Site were of waste generated during the D&D of the former Rockwell International Hot Laboratory (RIHL), which was used for thirty years for DOE-funded operations that included irradiated nuclear fuel examination and decladding. Five waste streams were initially defined and documented in the Rocketdyne "Application to Ship Radioactive Waste to the Nevada Test Site" (*Ref. 2*), submitted to NTS in response to Waste Acceptance Criteria (WAC) requirements (*Ref. 1*). Those waste streams were characterized by process knowledge, based on conditions specified in the 1992 revision of the WAC.

This SAP addresses additional waste streams from the environmental remediation of Area IV for which the conditions for characterization strictly by process knowledge are not met. Those waste streams encompass containerized, homogeneous materials that are readily sampled. The detailed sampling plan for each waste stream (including the number of containers to be sampled) will be incorporated in a sampling procedure specific to that waste stream that follows the protocol established in this SAP.

1.2 WASTE TYPES TO BE EVALUATED

This SAP provides quality assurance objectives and sampling methodology for the sampling and analysis of containerized waste. Wastes to be characterized in accordance with this SAP include those solid matrix waste forms generated during D&D activities which require confirmatory analytical data for characterization as low-level waste. They will be segregated ("stratified") as appropriate before being placed in containers, with the stratification based on process knowledge, visual evaluations, physical characteristics, and generating processes, and thus will be considered homogeneous in nature.

1.3 SAMPLING AND ANALYSIS PLAN OBJECTIVE

The objective of this SAP is to provide the protocol for obtaining legally defensible data for the characterization of previously generated, containerized waste to determine whether it complies with the waste acceptance criteria of approved radioactive waste disposal sites. The data shall be used, in conjunction with process knowledge associated with the waste streams, to meet requirements for waste shipment and disposal. In instances where insufficient sample volume exists, complete sampling may not occur.

1.4 USE OF PROCESS KNOWLEDGE

Process knowledge is a characterization technique that relies on the generator's knowledge of the physical, chemical, and radiological properties of the materials associated with the waste generation process, the disposition of those materials, and associated administrative controls. This information is developed through waste type evaluations, waste generation process and procedure reviews, surveillance of waste generation and packaging operations, employee interviews, historical operations reviews, outside source contamination controls, and administrative procedures. There are some cases where process knowledge must be used:

(a) The waste stream is difficult to sample because of physical form. This applies primarily to solid matrix waste such as metal, glass, or wood.

b) Sampling and analysis of the waste stream results in unacceptable risk of radiation exposure, (i.e., it violates ALARA, the As Low As Reasonably Achievable precept of the DOE).

c) The waste stream is too heterogeneous in composition (e.g., compactible trash containing clothing, paper, plastic, booties, and D&D waste).

This SAP was developed to address those cases where confirmatory sampling and analyses are required to support process knowledge, and those cases where the process knowledge is not of sufficient detail to qualify the waste. Process knowledge will be used to identify the analytical procedures required for each waste stream. For example, procedures used in the generation, collection, and stratification of the waste provide documentation of some of the physical and chemical properties, and will be used to guide the selection or omission of specific analyses. The use of process knowledge is shown in the flow diagram in Figure 1.

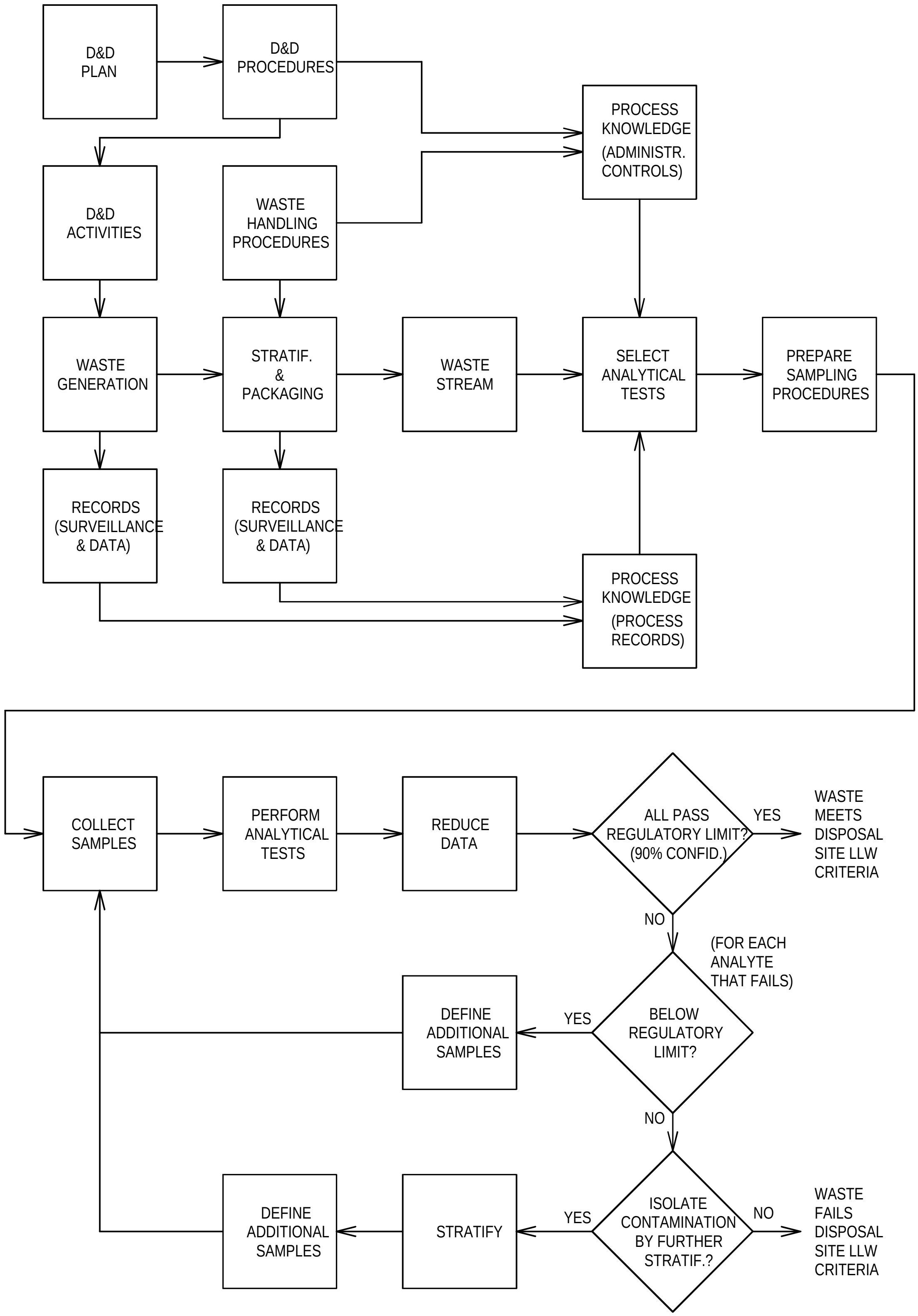

Figure 1. Flow Chart Showing the Use of Process Knowledge and Analytical Results for Waste Management Decision Making.

1.5 USE OF ANALYTICAL RESULTS

The results of the sampling and analysis conducted in accordance with this plan will be combined with existing process knowledge information to characterize containerized low-level D&D waste, providing compliance with the disposal site waste acceptance criteria. Specifically, the sampling strategy will ensure a confidence level of 90% that the average value of each measured hazardous analyte lies below the acceptance limit. If none of those analyte concentrations equal or exceed the acceptance limit (within the 90% confidence level), the results will provide sufficient evidence that the waste is non-hazardous low-level waste that is acceptable for disposal at approved sites prohibiting mixed waste. If one or more of the hazardous analyte concentrations equals or exceeds a regulatory threshold, an evaluation of the waste stream will be conducted to determine whether (1) additional sampling data can be collected to establish the 90% confidence level for meeting the acceptance limit, (2) the waste stream has localized contamination that can be removed by stratification, or (3) the waste stream does not qualify as non-hazardous low-level waste. The use of the analytical results in waste management decision making is shown in the flow diagram in Figure 1.

1.6 SAMPLING AND ANALYSIS SCHEDULE

An example schedule showing the projected start and completion dates for the sampling, analysis, and waste site shipment application for each waste stream subject to this SAP is shown in Table 1. The dates and durations are given relative to the Start Date (SD) for the sampling of each individual waste stream. In addition, the time interval between sample collection and sample analysis for each analytical procedure must not exceed the maximum allowable sample holding time, as listed in Section 7.4.

Table 1
D&D Waste Stream Sampling and Analysis Schedule

Task	Starting Day Number*	Ending Day Number*
Pre-sampling orientation & staging of containers	SD	SD + 5
Acquisition of sample containers and ice chests	SD	SD + 45
Sample collection	SD + 5	SD + 45
Sample transport to analytical laboratories	SD + 5	SD + 47
Laboratory analyses	SD + 7	SD + 95
Data evaluation QA/QC checks	SD + 55	SD + 100
Additional sampling (as required)	SD + 60	SD + 75
Preparation of waste stream characterization document	SD + 60	SD + 80
Preparation of Waste Stream Profile	SD + 75	SD + 80
Submittal of Waste Stream Profile to disposal site for approval		SD + 80

* The schedule for each waste stream is defined relative to the Start Date (SD) for the sampling of that waste stream.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The DOE Site Restoration and DOE Site Closure (Program Office) groups within the Safety, Health, and Environmental Affairs (SHEA) organization are responsible for radioactive waste management at the Santa Susana Field Laboratory. Site remediation is being performed under contract to the Department of Energy, with the objective of site closure in September 2006. The DOE Site Restoration group performs the site remediation tasks and the DOE Site Closure group provides the program management. Both groups report to the SHEA Division Director, who in turn reports directly to the Vice President and General Manager of Boeing Canoga Park (Rocketdyne Propulsion & Power). Site Restoration personnel have extensive experience in D&D and waste handling activities, with past activities including the decommissioning and free-release of several nuclear facilities both at the Santa Susana Field Laboratory and at off-site locations.

Several other Boeing Canoga Park organizations support the D&D and environmental restoration activities, including the characterization of the radioactive waste streams. These organizations include Radiation Safety, Quality & System Safety, Operations, and People & Communications.

The company structure related to radioactive waste management is shown in Figure 2, and a flow chart showing the relationships between the organizations responsible for the processes leading to waste stream characterization and shipping is shown in Figure 3.

2.1 DOE SITE RESTORATION

DOE Site Restoration is responsible for the D&D and the radioactive waste management operations associated with the environmental remediation of Area IV of the Santa Susana Field Laboratory. The radioactive materials waste management activities include procedure writing, record keeping, sampling and analysis, packaging, and shipping for all radioactive materials. Site Restoration is responsible for the preparation of disposal-site applications and DOE-related procedures, compliance with disposal-site waste certification criteria, and the establishment and maintenance of training programs for radioactive waste handling and packaging. Site Restoration also includes the personnel responsible for technical support in the area of non-nuclear environmental compliance during waste generation, sampling, characterization, and packaging. That includes expertise in Resource Conservation and Recovery Act (RCRA) and California Title 22 (*Ref. 3*) compliance issues and in sampling and analysis activities. The responsible personnel will also conduct audits of generating-facility activities and waste packaging operations to ensure compliance with applicable rules and regulations and with the waste acceptance criteria of approved waste disposal sites.

2.2 DOE SITE CLOSURE

The Program Office is responsible for managing the DOE site environmental remediation and closure contract. Activities include task management, budgeting, and customer interfaces.

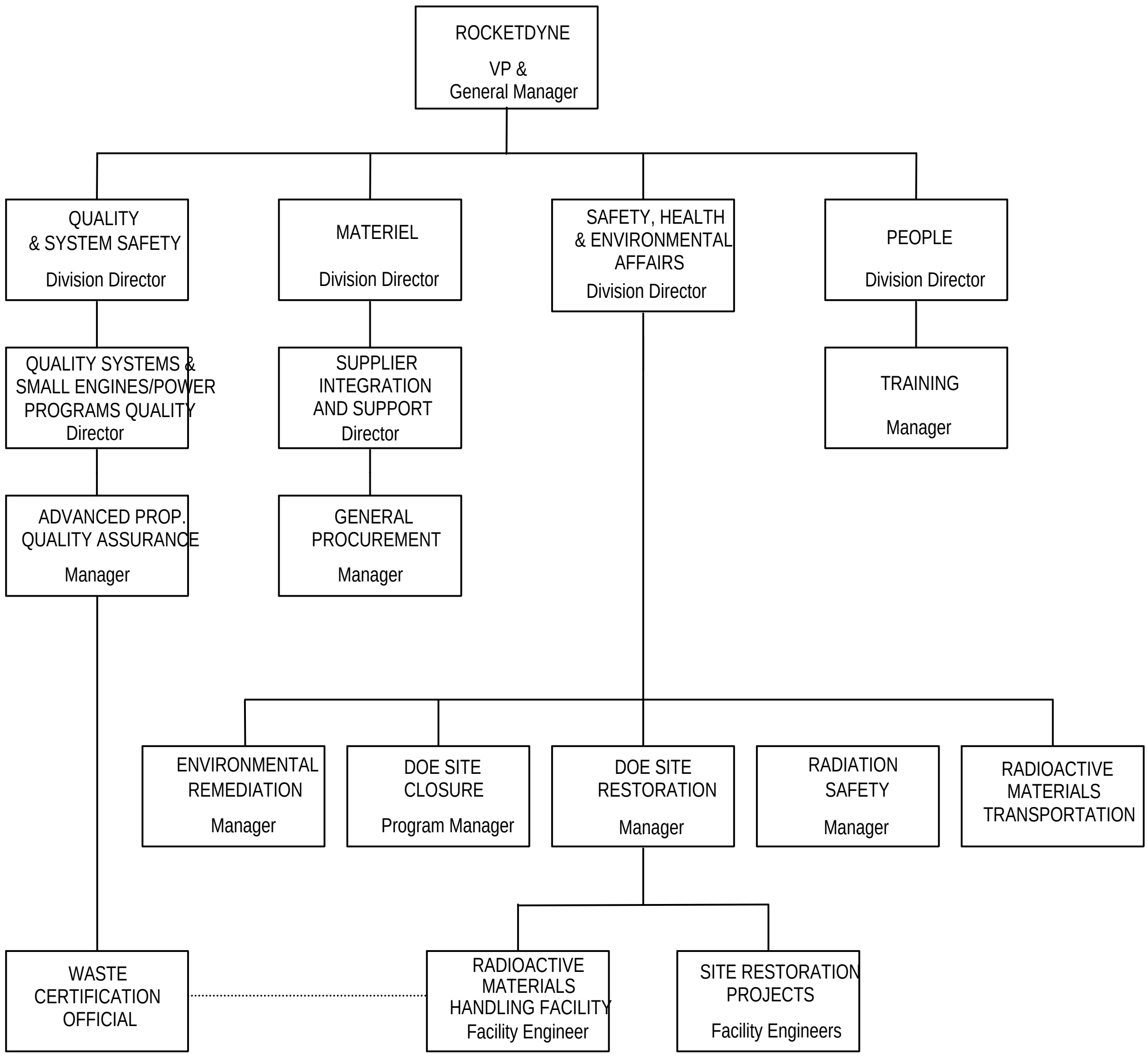

Figure 2. Company Structure Related to Radioactive Waste Management.

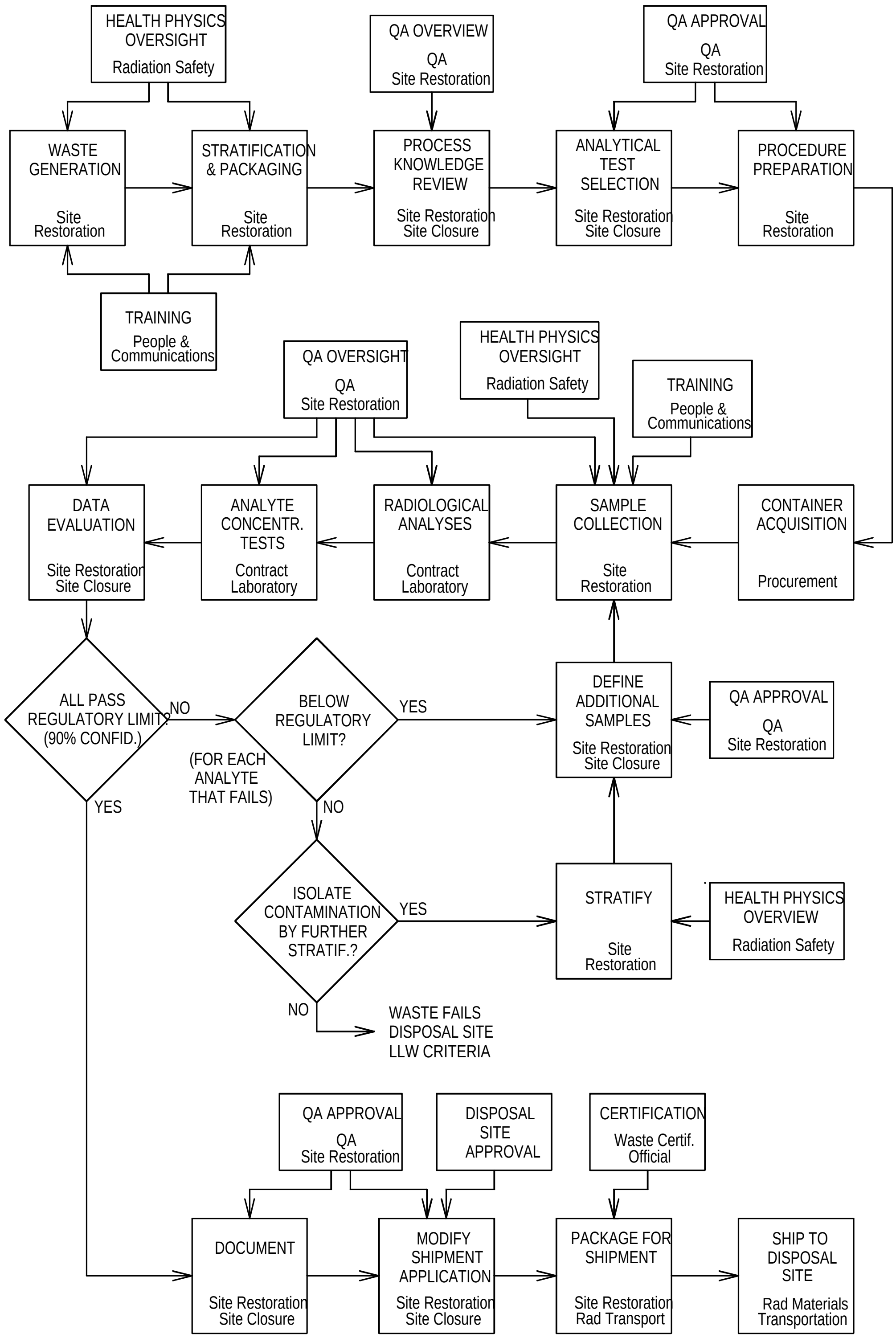

Figure 3. Flow Chart Showing the Relationships Between the Organizations Responsible for the Processes Leading to Waste Stream Characterization and Shipping.

2.3 RADIATION SAFETY

The Radiation Safety group is responsible for providing the required radiological support during waste generation, packaging, and shipping. Its activities include the radiological characterization of the waste and radiological surveillance of D&D operations, waste stratification and packaging, and waste transportation.

2.4 QUALITY & SYSTEM SAFETY

Boeing Canoga Park's Quality & System Safety organization has an oversight and approval responsibility for the characterization (sampling and analysis) and documentation of the waste stream in preparation for its shipment to an approved disposal site. This oversight is independent of the DOE Site Restoration and Site Closure groups. The QA organization structure, its relationship to the Boeing Canoga Park organization, and its responsibilities in the area of radioactive waste management, including waste certification are detailed in Boeing Canoga Park Document QA-00001, "Quality Assurance Program Plan for ETEC Closure" (*Ref. 4*).

2.5 OTHER BOEING CANOGA PARK SUPPORT ORGANIZATIONS

Other Boeing Canoga Park support organizations and their responsibilities include:

• Environmental Remediation (SHEA)	General support in chemical characterization, QA, and data validation.
• Procurement (Materiel)	Purchase of supplies, analytical services, and equipment used during waste generation and packaging activities.
• Radioactive Materials Transportation (SHEA)	Transportation of radioactive materials off site in compliance with Department of Transportation (DOT) requirements and regulations.
• Training (People)	Training of personnel and training record keeping.

2.6 CONTRACT ANALYTICAL LABORATORIES

Boeing Canoga Park contracts with multiple outside analytical laboratories to perform the chemical and radiological analytical services specified in the sampling and analysis procedures for each containerized waste stream. This provides both primary and backup service capabilities. Boeing personnel have conducted supplier audits at the outside facilities used, and those audits have found the laboratories to be in compliance with technical and quality assurance requirements. Similar audits will be performed at any additional laboratories identified for contract activities. The organizational structures and responsibilities of the contracted laboratories are incorporated in their individual Quality Assurance Management Plans.

3.0 COMPLIANCE WITH DISPOSAL SITE WASTE ACCEPTANCE CRITERIA

Individual radioactive material disposal sites have specific requirements for waste acceptance of defense waste. Each site requires that the waste be radioactive and meet specific minimum requirements to facilitate handling and to provide health and safety protection to personnel at the disposal site. The general waste criteria applicable to waste stream characterization are addressed below, with the organization based on NTS criteria (*Ref. 1*).

3.1 TRANSURANICS

DOE Order 435.1 (*Ref. 5*) specifies that low level waste (LLW) must have a transuranic (TRU) nuclide concentration less than 100 nCi/g. Boeing Canoga Park radiological surveys, sampling, and analyses are conducted in accordance with Operating Procedure RS-00011, "Procedures for Surveys of Radioactive Material Shipments" (*Ref. 6*). Radiological data generated for all samples analyzed to date from the containerized waste streams, with the exception of liquid waste tank and drain system samples, identify the principal radionuclides as ^{137}Cs, ^{60}Co, and ^{90}Sr. The determination of whether a given waste stream meets the TRU concentration limit will be made based on existing analytical data (where available) or additional testing. There is a transuranic nuclide concentration in the waste stream composed of drain line sludge and debris removed from the radioactive liquid hold-up tank/drain line system of the former Hot Laboratory. Material in that waste stream has been segregated from low level waste streams pending sampling in accordance with this SAP for isotopic analysis and determination of TRU content. Any waste found to exceed the specified limits will remain segregated and documented as prohibited from shipment to a disposal site as LLW.

3.2 HAZARDOUS WASTE COMPONENTS

Low level waste acceptance criteria specify that waste sent for disposal shall not exhibit any characteristics of, or be listed as, hazardous waste as identified in 40 CFR 261 (*Ref. 7*), State of Nevada regulations, or state-of-generation hazardous waste regulations (22 CCR 66261, *Ref. 3*). To ensure compliance with this criterion, samples shall be characterized in accordance with State of California and Federal regulations. State characterization procedures include the Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) procedures, which measure the concentrations of persistent and bioaccumulative toxic substances extracted using the Waste Extraction Test (WET). If a measured concentration equals or exceeds the waste or waste extract limit specified in Title 22, California Code of Regulations (*Ref. 3*), the waste is defined as hazardous. The Federal Toxicity Characteristic Leaching Procedure (TCLP) may also be required to determine specific Resource Conservation and Recovery Act (RCRA) toxicity characteristics. The TTLC and STLC are more rigorous tests and have the ability to measure additional metal constituents. Waste will be sampled for specific Title 22 metals and/or organics based on available process knowledge. If little is known about the potential contaminants in a waste, analytical tests for additional substances will be conducted. Analytical results obtained in accordance with this plan will ensure compliance with disposal site low level waste acceptance criteria. Any material identified as containing hazardous components will be segregated and documented as prohibited from shipment to a low level waste disposal site.

3.3 FREE LIQUIDS

Disposal site waste acceptance criteria specify that LLW shall contain as little freestanding and non-corrosive liquid as is reasonably achievable. The NTSWAC prohibits free liquids to exceed 1 percent of the volume of the waste when the waste is in a disposal container, or 0.5 percent of the volume of the waste processed in stable form. The Boeing Canoga Park containerized waste streams are all solid wastes which have been stored in metal boxes or drums, in most cases indoors or under cover. It is not anticipated that free liquids will be present, but compliance with this criterion will be verified by visual inspection and surveillance during sampling operations. If a waste form is suspected to contain free liquids, it will be sampled and tested using Environmental Protection Agency (EPA) Test Method 9095, "Paint Filter Liquid Test" (*Ref. 8*).

3.4 PARTICULATES

Disposal site acceptance criteria require that fine particulate wastes be immobilized. The NTSWAC requires that the waste package contain no more than 1 weight percent of less-than-10-micrometer-diameter particles, or 15 weight percent of less-than-200-micrometer-diameter particles. Boeing Canoga Park waste which may contain particulates will be sampled for particle size distribution to verify compliance with this criterion.

3.5 GASES

Disposal site waste acceptance criteria require that LLW gases be stabilized or absorbed so that pressure in the waste package does not exceed 1.5 atmospheres at 20 °C (for NTS) and that the waste include no compressed gases as defined by Title 49, CFR 173.300 (*Ref. 9*), including unpunctured aerosol cans. Any aerosol cans must have puncture disfigurements recognizable by real-time radiography, and expended gas cylinders must have their valve mechanisms removed. Gases, cylinders, and aerosol cans are not present in the Boeing Canoga Park containerized waste streams, based on process knowledge (stratification operations and packaging procedures). No analyses are necessary to verify compliance with this criterion.

3.6 STABILIZATION

Disposal site waste acceptance criteria specify that, where practical, waste shall be treated to reduce volume and provide a more structurally and chemically stable waste form. The Boeing Canoga Park waste forms comprising the waste streams addressed by this SAP are structurally and chemically stable (process knowledge based on stratification operations), and minimize volume to reduce disposal costs (process knowledge based on packing procedures). No analyses are necessary to verify compliance with this criterion.

3.7 ETIOLOGIC AGENTS

Disposal site waste acceptance criteria specify that LLW contain no pathogens, infectious wastes, or other etiologic agents as defined in Title 49, CFR 173.386 (*Ref. 9*). No etiologic agents are suspected in any Boeing Canoga Park waste to be sampled in accordance with this SAP, based on process knowledge (facility history and dismantlement procedures). No analyses are necessary to verify compliance with this criterion.

3.8 CHELATING AGENTS

Disposal site waste acceptance criteria require that LLW contain chelating or complexing agents at concentrations no greater than 1 percent by weight of the waste form (for NTS). No chelating agents are suspected in any waste to be sampled in accordance with this SAP. No analyses are necessary to verify compliance with this criterion, based on process knowledge (facility history and dismantlement procedures).

3.9 POLYCHLORINATED BIPHENYLS

Disposal site waste acceptance criteria specify that LLW contaminated with polychlorinated biphenyls (PCBs) will not be accepted for disposal unless the PCB concentration meets municipal solid waste disposal levels of 50 ppm or less (for NTS). Most wastes to be sampled in accordance with this SAP do not include components that could contain PCBs, based on process knowledge. Boeing Canoga Park systematically removes all PCB-containing items from the site under the guidance of the Environment Remediation group. All electrical transformers, fluorescent lighting ballasts, mercury vapor lighting ballasts, and other potential PCB-containing items are segregated, decontaminated, and disposed of as non-radioactive hazardous waste. Any containerized waste stream with potential for PCB contamination will be analyzed for PCBs using EPA Method 8080 (*Ref. 8*) to verify compliance with this criterion.

3.10 EXPLOSIVES

Disposal site waste acceptance criteria prohibit LLW capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with waster. No explosives are suspected in any waste to be sampled in accordance with this SAP, based on process knowledge (facility history and dismantlement procedures). No analyses are necessary to verify compliance with this criterion.

3.11 PYROPHORICS

Disposal site waste acceptance criteria require that any pyrophoric materials contained in a waste be treated, prepared, and packaged to be nonflammable. No pyrophoric materials are suspected in any waste to be sampled in accordance with this SAP, based on process knowledge (facility history and dismantlement procedures). No analyses are necessary to verify compliance with this criterion.

3.12 SEALED SOURCES

The NTS waste acceptance criteria require that sealed sources be segregated from other waste and handled as a separate waste stream. Any sealed sources shipped to NTS as waste will be segregated and characterized on an individual source basis. Sources sent to another disposal site will conform to that site's WAC.

3.13 LOW-LEVEL WASTE CONTAINING ASBESTOS

The NTS waste acceptance criteria specify that LLW containing regulated asbestos-containing materials conform to packaging, marking, and labeling requirements of Title 40 CFR (*Ref. 7*), State of Nevada, state of generation, and the NTS Management Plan, and meet the applicable shipping requirements for the radioactive contents of the package. Boeing Canoga Park does not currently send any asbestos-containing low-level waste to NTS for disposal. Any future shipments of asbestos-containing materials will conform to the requirements specified by the waste acceptance criteria of the selected disposal site.

3.14 RADIOACTIVE ANIMAL CARCASSES

The NTS waste acceptance criteria specify packaging requirements for the shipment of animal carcasses containing, or contained in, radioactive materials. Boeing Canoga Park does not ship radioactive animal carcasses to NTS, and any such shipments to another disposal site will conform to the requirements specified by the selected site's waste acceptance criteria.

4.0 QUALITY ASSURANCE

Quality assurance is a management system for ensuring that all information, data, and decisions are technically sound and properly documented. All sampling and analysis activities performed by Boeing Canoga Park and/or its contracted analytical laboratories shall be performed in accordance with Quality Assessment/Quality Control (QA/QC) practices described herein and in the individual quality assurance management plans of the contracted laboratories. Contract laboratory QA/QC verification has been conducted at those laboratories used through on-site inspections and audits by Boeing QA personnel. Those audits have verified compliance with approved disposal site requirements. QA/QC verification audits will continue throughout the time of the contracted services both by periodic on-site visits and the evaluation of analytical control samples. The qualification of multiple laboratories provides Boeing Canoga Park with both a primary and a backup laboratory for individual analysis requirements. If any additional laboratory is to be used for analytical measurements, it shall be similarly audited to verify compliance with disposal site QA/QC requirements.

4.1 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) for waste stream sampling refer to the overall level of uncertainty that a decision-maker is willing to accept in results derived from the sampling data. In those cases where multiple measurements are used to compare an average value with a regulatory or acceptance limit, a confidence level of 90% has been established for making the determination of whether that average value lies below the limit. This defines the quality of the measurement data required, addressed in terms of objectives for precision, accuracy, representativeness, comparability, and completeness (PARCC). The data quality objectives to be followed for the sampling and analysis procedures that are governed by this SAP are as follows:

(1) Non-Radiological Analyses: Determine whether the waste stream exhibits hazardous waste characteristics for those analytes tested by the selected analytical methods, using a 90% confidence level as specified in SW-846 (*Ref. 8*) where appropriate, and quantify measurable concentrations.

(2) Radiological Analyses: Determine the primary non-background radionuclides present in the waste stream, and quantify their radiological activities.

4.2 MEASUREMENT QUALITY ASSURANCE

The general QA/QC practices that shall be followed in the implementation of this Sampling and Analysis Plan are summarized below. More detailed practices used in the analytical procedures (sample handling, chain of custody, calibration, preparation of reagents and standards, data reduction, quality control checks, etc.) are contained in the audited Quality Assurance Management Plans of the individual laboratories.

4.2.1 Field Quality Assessment/Quality Control

Field QA/QC is ensured by uniform sample collection, handling, chain of custody and shipping procedures, thorough training of field sampling and shipping personnel in those procedures, and evaluation of quality control samples collected in the field. Periodic QA audits are performed to assess compliance with procedures and training. Several different types of field samples are collected and evaluated specifically to assess the quality control aspects of sample collection and handling. Those different types of field samples include:

- ***Field Duplicate:*** A field duplicate is an independent sample collected at the same location as one of the field samples. It is used to monitor the precision of the sampling and analytical procedures, as differences between its characterization and that of the co-located field sample will be influenced by variances in the waste composition, sampling technique, and analytical technique. One field duplicate shall be collected on each day of sampling for each 10 field samples or each sample matrix sampled, whichever is more frequent.

- ***Field Blank (Equipment Blank, Rinsate):*** A field blank, also referred to as an equipment blank or a rinsate, is usually a metal and/or organic-free water aliquot (such as ASTM 1193 Type II or higher purity water) that contacts the sampling equipment. It is collected as the final rinsate after the equipment is decontaminated between sample collection procedures, and is used to detect any cross contamination between samples or from sampling conditions. One field blank shall be collected on each day of sampling for each 20 field samples (more often if needed) or each sample matrix sampled, whichever is more frequent.

- ***Trip Blank:*** A trip blank is an analyte-free media such as distilled water that is transported unopened from the laboratory (or other sample container source) to the sampling site and is then returned to the laboratory with each set of samples. This blank monitors any contamination that may be attributable to shipping and handling of the sample containers, and is used only when volatile organics are analyzed. One trip blank shall be included for each day of sampling, and shall be transported in the cooler used for preservation and transport of the volatile organic samples.

- ***Matrix Spike and Matrix Spike Duplicate:*** Matrix spikes and matrix spike duplicates are sample materials spiked (fortified) with known quantities of the analytes of interest and analyzed with the associated sample batch to monitor the effects of the sample matrix on the analytical method. Sufficient additional sample material shall be collected at one of the sampling locations (for every 20 locations or each sample matrix sampled, whichever is more frequent) to allow the analytical laboratory to prepare a matrix spike and a duplicate for each analytical method employed.

4.2.2 Laboratory Quality Assessment/Quality Control

The detailed QA/QC analytical laboratory practices are specified in the laboratories' individual Quality Assurance Management Plans. An outline of the laboratory controls to be implemented to ensure the production of precise, accurate, defensible data follows.

4.2.2.1 General Laboratory Controls

The analytical controls that are required of the laboratories performing the analyses are listed below. These requirements are standard in a Certified Laboratory and are verified during laboratory audit, inspection, and validation processes.

- Reagents and solvents shall have certified compositions.
- Reagent storage environment and duration shall meet the manufacturers' guidelines.
- Laboratory equipment shall be calibrated/standardized following the reference procedures for the methods used, and those calibrations shall be documented.
- Volumetric measurements shall be made with certified glassware.
- Data reduction computations shall be checked independently.
- Qualified personnel shall be used for laboratory analyses.
- QA/QC control requirements specified for the analytical methods shall be followed.

4.2.2.2 Laboratory QA/QC Samples

In addition to the general laboratory controls listed above, the quality control program shall include the analysis of blank, spiked, and duplicate samples to evaluate the accuracy and precision of the analytical systems. These quality control samples shall be analyzed with every analytical batch or every 20 samples, whichever is more frequent. Examples of the types of quality control samples that shall be included are given below.

- ***Method Blank (Reagent Blank):*** A method blank is typically an organic or aqueous solution that is free of the analyte to be measured, but is processed chemically, analyzed, and reported in the same manner as a field sample. It is used to detect possible contamination resulting from the preparation or processing of the sample.

- ***Method Blank Spike:*** A method blank spike is a sample of laboratory reagent-grade water that is spiked with a known quantity of analyte. It is prepared and analyzed along with the field samples, and provides a measure of the accuracy of the analytical method.

- ***Matrix Spike:*** A matrix spike is a duplicate field sample that is spiked with a known quantity of the analyte of interest and analyzed along with the field samples. It provides a measure of the accuracy of the analytical method when used with the specific sample matrix.

- ***Matrix Spike Duplicate:*** A matrix spike duplicate is a split sample where the two sample components are spiked with identical concentrations of organic analytes to determine the precision of measuring organic samples.

- ***Laboratory Duplicate Sample:*** A laboratory duplicate sample is a duplicate field sample obtained by splitting a field sample in the laboratory and performing separate analyses on the two components. This monitors laboratory precision, but may be affected by sample non-homogeneity.

- ***Laboratory Control Sample:*** A laboratory control sample is a standardized sample prepared independently from the test samples and having a certified concentration of the analyte. It is equivalent to a method blank spike and is analyzed with the field samples to monitor analytical accuracy.

- ***Laboratory QC Check Sample:*** A laboratory QC check sample is a reference sample of known concentration that was obtained from the EPA, the National Institute of Standards and Technology (NIST), or from a Nuclear Regulatory Commission (NRC)-approved commercial source. It is also analyzed with the field samples to monitor analytical accuracy.

4.2.2.3 Method Detection Limits

The method detection limit for an analytical test is defined in the Environmental Protection Agency (EPA) document SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (*Ref. 8*), as the minimum concentration of an analyte that can be measured and reported with 99% confidence to be greater than zero. It is determined from the analysis of field-equivalent matrix samples spiked with a known concentration of the analyte of interest. A minimum of three laboratory analyses are required, with an analyte spike concentration three to five times higher than the estimated method detection limit, and the limit is then calculated using a t-distribution analysis. For day-to-day measurements, however, the estimated quantitation limit is expected to be a more practical detection limit for data evaluation purposes. It is defined as the lowest concentration that can be achieved reliably within specified limits of precision and accuracy during routine laboratory operating conditions, and may be 5 to 10 times the method detection limit (*Ref. 8*). The estimated quantitation limit (or method detection limit, if appropriate) shall be reported by the analytical laboratory for each analyte whose concentration is found to be below detection limits.

4.3 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, & COMPLETENESS (PARCC)

The precision, accuracy, representativeness, comparability, and completeness (PARCC) criteria addressed in each sampling effort will aid in evaluating the quality of data and will ensure that all decisions based on laboratory and field data are technically sound, statistically valid, and properly documented.

4.3.1 Precision

Precision measures the agreement among a set of replicate measurements without assumption of knowledge of the true value. It is a quantitative measure of the variability of a group of measurements relative to their average value ($\bar{x}$). Precision is assessed by means of laboratory duplicate and field duplicate sample analyses and is usually stated in terms of the standard deviation (s) or coefficient of variation $\nu = 100\left(s / \bar{x}\right)$ of the measurement values. The average value $\bar{x}$ and standard deviation s of a set of measurements are defined in Section 5.3.

Field precision will be addressed by duplicate samples and field audits performed on a routine basis. The audits will document the use of uniform sampling methods and of specified handling and shipping procedures. Laboratory precision will be evaluated by the measurement of the laboratory duplicate samples.

4.3.2 Accuracy

Accuracy measures the nearness of a result, or the average of a set of results, to the true value (field samples) or reference value (laboratory controls). It will be determined by the evaluation of the results of field/trip blanks, laboratory control samples, laboratory QC check samples, and matrix spikes. Accuracy, as expressed as a measurement of uncertainty, is composed of two components, a random uncertainty (associated with measurement precision) and a systematic error. The systematic error (or bias) is often expressed as a percent recovery (*%R*) of a known concentration of an analyte in a sample, as defined in SW-846 (*Ref. 8*):

$$\%R = 100\left(x_s - x_u\right) / K$$

Here x_s is the measured value of a spiked sample, x_u is the measured value of an unspiked sample, and K is the known value of the spike in the sample. The recovery percentage will be evaluated as part of the laboratory procedures and recorded on the analytical QC forms. If the results fall outside internal limits, the analytical procedures and systems will be investigated, and the samples will be re-analyzed.

4.3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The representativeness of a data set is addressed by designing the sample collection procedure to provide an unbiased set of samples that are representative of the entire waste inventory. It will be satisfied by making sure that the sampling locations are selected properly (representative of a given point in space and time), a sufficient number of samples are collected, and the collection procedures are performed properly.

For example, the following criteria must be met to provide evidence of representativeness:

- The sample selection is unbiased.
- The collection of samples in space and time is representative of the waste stream.
- Sampling equipment and containers meet acceptability requirements for the analytes to be analyzed.
- The sampling procedure does not alter the analytes or parameters to be measured.
- Sample handling procedures meet sample preservation criteria.

- There is no evidence of field blank contamination.
- There is no evidence of cross-contamination between collected samples.

4.3.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which different data sets can be compared. It is an important consideration when data sets are generated from samples collected at different times or places or in different manners, or when the sample sets are analyzed by different laboratories or procedures. Comparability will be addressed by using standard techniques to collect and analyze field samples. Analytical results will be reported in appropriate units for comparison to historical data, if available. The present contract analytical laboratories have extensive internal performance evaluation audit programs and participate in external intercomparison programs; any new laboratories will be evaluated for similar interlaboratory comparison participation. If multiple data sets are generated as representative of the same analytes for the same waste stream, and are found not to agree within statistically acceptable limits, resampling and reanalysis procedures will be implemented if the discrepant results have a potential effect on waste management disposal decisions.

4.3.5 Completeness

Completeness is a measure of the amount of valid data obtained from a sampling and analysis program relative to the data base specified in the sampling and analysis procedures. The waste stream analyst will evaluate the completeness of the data.

4.4 SURVEYS/AUDITS

The Boeing Canoga Park Quality & System Safety organization performs surveys (on-site evaluations) of the laboratory procedures of candidate analytical laboratories prior to issuing a contract, to assure conformance to recognized quality assurance procedures. QA and laboratory specialists (from Radiation Safety, Environmental Remediation, and/or DOE Site Restoration) will perform periodic audits of contractor laboratories used to perform analyses in accordance with this plan.

5.0 SAMPLING STRATEGY

The sampling strategy and associated sampling procedures are an important component of the characterization of a waste stream, as they establish the accuracy and precision of the characterization. This section defines the sampling strategy and approach to be used for each of the applicable waste streams. A separate sampling procedure shall be prepared for each waste stream based on this plan. That procedure shall include the details of sample selection, collection, handling, preservation, and transport. The sampling activities shall be conducted in accordance with the quality assurance (quality control and quality assessment) objectives outlined in Section 4. The sample selection process, and the subsequent statistical interpretation of sample analysis data, shall be guided by Chapter 9 of EPA SW-846, “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods” (*Ref. 8*).

5.1 SAMPLING OBJECTIVE

The objective of the waste stream sampling is to obtain a set of samples that are representative of the average properties of the whole waste stream for subsequent physical and chemical analyses. The results of these analyses will be used to determine the suitability of the waste stream for disposal at the selected disposal site. Suitability is defined by requiring that the concentration level of each analyte (contaminant) of concern conform to the disposal site waste acceptance criteria. For a low level waste site, each analyte concentration level must have a 90% confidence of being below the acceptance limit, based on defensible data and statistical analyses. If the criteria of the selected disposal site are not met, the sample data shall provide adequate waste stream characterization to address requirements for acceptance at other disposal sites.

5.2 SAMPLING APPROACH

The sampling approach to be used for the characterization of the waste streams subject to this SAP is designed to minimize sampling bias and have a high probability of providing data that are representative of the waste inventory. Each of the waste streams was generated by prior stratification (segregation) of the facility D&D waste, and was thus established with administrative controls and process knowledge. Accordingly, the chemical properties of each waste stream are not expected to be significantly different over time and space, and a simple random sampling strategy will be used for each waste stream to collect analysis samples.

Simple random sampling is also appropriate because there is little or no information available concerning the distribution of potential chemical contaminants. Multiple samples shall be collected in order to establish the homogeneity of the waste. If the measured variability of contaminants is large, and the average concentration levels are within (or near) acceptance limits, further sampling will be performed as practical to increase the confidence level of the measured results. The specification of the number of samples is addressed in Section 5.3.

Sample site selection will be based on true random sampling, with containers labeled and/or gridded with identification numbers to establish a sampling matrix. Individual sampling locations will be selected from within this matrix by the use of a random number generator computer program. The use of a computer program is specified instead of a random number list in order to eliminate the potential for bias or error in selecting or reading from such a list.

A very simple BASIC personal computer program that will generate random numbers is shown below, based on the selection of **n** integer numbers between the integer values of 1 and **m**.

```
RANDOMIZE TIMER
FOR i = 1 TO n
number = INT (RND(TIMER) * m) + 1
PRINT number
NEXT i
END
```

This program does not test for repeated numbers; each repeated number can be substituted for with a new random number generated by re-running the program and using the next non-repeating number. The program statement "RANDOMIZE TIMER" provides a random number "seed" based on the computer clock time, where TIMER returns the number of seconds elapsed since midnight, and thus avoids regeneration of the same list of numbers that would occur had it not been included.

The sampling approach to be followed for each waste stream also includes the collection of a number of control samples, field blanks, rinsate samples, and trip blanks, as identified under Quality Assurance. The detailed sampling procedures shall specify the numbers and locations of each of these samples.

5.3 NUMBER OF SAMPLES

The random sampling approach described above is intended to provide representative samples of waste that exhibit average properties of the whole waste. Since the concentration of a given analyte in a waste stream will be variable, even for a homogeneous waste, multiple samples must be collected and analyzed to provide a good estimate of the average concentration. The variability in these values provides an estimate of the precision of the measurements, and is used to assess the confidence with which the average concentration is known. For a large number of samples (≥ 30) from a homogeneous waste, the analyte concentration measurements will follow a normal (bell-shaped) distribution. The analyte concentration is judged to be below a regulatory threshold with 90% confidence if all but the upper 10% of the bell-shaped curve is below that threshold value. If fewer (< 30) samples are taken, the bell-shaped curve spreads out and becomes a "t-curve," with the width of the curve dependent upon the number of measurements (the fewer the number of samples, the wider the curve). For an analyte to be considered below the regulatory threshold when only a few samples are analyzed, 90% of the t-curve area must lie below that threshold.

The number of samples required to show that an analyte concentration is below the threshold with 90% confidence depends upon the variability of the waste (e.g., the standard deviation of the measured values). If estimates of the analyte average value and standard deviation are available, the number of samples n required from a given waste stream can be calculated from Equation (8) in EPA SW-846 (*Ref. 8*):

$$n = \frac{{t_{0.20}}^2 s^2}{\Delta^2} \quad . \tag{1}$$

Here Δ = (regulatory threshold)-(measured average) and s^2 is the variance in the initially measured average of m samples. The variance is calculated from the measured values by

$$s^2 = \frac{1}{m-1}\left[\sum_{i=1}^{m}(x_i - \bar{x})^2\right], \tag{2}$$

where x_i is the ith measurement of the variable x, $\bar{x}$ is the average value of x, and the standard deviation s is related to the variance s^2 by $s = \sqrt{s^2}$. The average value of the m measurements is defined as:

$$\bar{x} = \frac{1}{m}\sum_{i=1}^{m} x_i \quad . \tag{3}$$

The quantity $t_{0.20}$ in Equation (1) is the tabulated Student's t value for a <u>two</u>-tailed confidence interval with a probability of 0.20. Statistically, this represents an 80% confidence that the true average waste concentration is in neither the upper tail nor the lower tail of the bell-shaped distribution. Since we are interested only in the upper tail of the distribution, this effectively becomes a 90% confidence test. The $t_{0.20}$ value is obtained from standard statistical tables for a two-tailed t test, with the number of degrees of freedom equal to the number of samples minus one. These values are equal to the values of $t_{0.10}$ for a <u>one</u>-tailed t test, which considers only one tail of the distribution. Values of t for a 90% confidence level are tabulated in Appendix B.

In most cases, the waste streams addressed by this SAP have not been sampled previously, and there are no previous data for the individual analytes that provide an estimate of the average concentrations or variabilities. An alternative approach shall be used in these cases, based on the sampling of 10% of the waste containers. However, the minimum number of analysis samples to be collected for hazardous material analyses for each waste stream shall be four, based on EPA requirements for petitions to exclude wastes from being listed as hazardous wastes (*Ref. 8*).

Table 2 provides general guidance for the minimum number of samples required for analyte chemical analyses. In those cases where the number of containers is greater than four, those containers to be sampled (≥ 4) will be selected using a random number generator computer program, as described above. Other than control samples, only one sample shall be taken from each container. In those cases where the number of containers is less than or equal to four, all containers will be sampled, and multiple samples may be taken from some. Here the sampling locations within the containers will be determined by gridding the containers into volume zones and selecting the zones to be sampled (at least 4 total) using a random number generator. Additional samples shall also be collected as field duplicates, based on the SW-846 criterion of one field duplicate for each set of samples (each matrix sampled) per day of sampling. The field duplicates will be collected at locations adjacent to other samples, providing information on sampling and analysis precision; they do not provide independent samples to be included in statistical averages. Additional quality control sampling requirements are outlined in Section 4.

Table 2
Guidance for Minimum Number of Samples Required for Analysis

Number of Containers in Waste Stream	Number of Samples Required for Analysis
1 to 40	4
41 - 50	5
over 50	# of containers x 10%

This approach is expected to provide adequate sampling to establish whether the analytes meet the acceptance criteria of the selected disposal site. In those cases where an analyte is below the site's regulatory threshold but does not meet the 90% confidence level, a case-by-case judgment will be made whether to classify the waste as not acceptable for disposal and dispose of it at an alternative site, or to collect and analyze additional samples. That judgment will be based on whether other analytes also fail the criteria, and the relative cost-effectiveness of additional sampling versus alternative disposal. The statistical analysis of a larger number of samples will produce a narrower t-curve (if the waste is homogeneous), and thus increase the confidence level in the measured average analyte value. If additional sampling is performed, the average and standard deviation from the first measurement set, plus Equation (1), will be used to determine the number of additional samples required to reach the 90% confidence limit.

This sampling approach is based on the assumption that the stratified waste streams are relatively homogeneous. If the measured sample variability is extremely large, with some individual concentration values well above the regulatory threshold, the waste may be judged as heterogeneous. In that case, consideration will be given to either classifying the entire waste stream as unacceptable for disposal at the selected site or re-stratifying and re-characterizing. One test for heterogeneity will be a calculation of the number of additional samples required per SW-846 Equation (8); the number of samples would be impractically large.

The determination of whether a measured analyte concentration meets the 90% confidence level is based on the calculation of the confidence interval for the measurement. This confidence interval is given by

$$\bar{x} - t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right) \quad \text{to} \quad \bar{x} + t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right) \tag{4}$$

where $\bar{x}$ is the sample average, s is the standard deviation, and n is the number of samples. The t value $t_{\alpha/2} = t_{0.10}$ is the <u>one</u>-sided Student's t value for df = n-1 degrees of freedom; a table of values (equal to $t_{0.20}$ for a two-tailed test) is given in Appendix B. If the right-side value in Equation (4) is below the regulatory threshold, the analyte meets the acceptance criterion.

6.0 SAMPLE ANALYSIS STRATEGY

This section provides guidance for selecting the required non-radiological and radiological analyses to be conducted for characterization of each containerized waste stream in accordance with disposal site requirements. Non-radiological analyses will be performed in accordance with SW-849, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (*Ref. 8*). Analytical procedures for radiological analyses shall be performed in accordance with standardized radiological characterization procedures.

The specific analyses to be performed will be determined independently for each waste stream, and the required analyses shall be identified in the waste stream sampling procedure. This determination will be made based on previously documented process knowledge, time and process of generation, availability of analytical data, and radiological survey results. Laboratory analysis procedures to be considered for the characterization of a given waste stream are outlined below.

6.1 NON-RADIOLOGICAL ANALYTES AND PROPERTIES

Individual non-radiological waste stream properties and analytes to be characterized either by process knowledge or laboratory analysis are summarized in Table 3, along with the analytical methods that will be employed where laboratory procedures are required.

In the case of the Nevada Test Site, regulations classify a waste stream as hazardous if it is so classified in the state of origin, even if it meets Federal regulatory limits. Since the ETEC waste streams originate in California, and State of California hazardous waste standards are somewhat more restrictive that Federal standards, the California criteria will be considered first. The California hazardous waste criteria address the total concentration of the constituents of interest, and also require independent leachability tests for specific waste constituents. The Federal criteria are based on the soluble (or leachable) fraction of several specified analytes. The analysis/evaluation approach to be used here will incorporate Waste Extraction Test (WET) procedures plus Total Threshold Limit Concentration (TTLC) measurements first, followed by Soluble Threshold Limit Concentration (STLC) measurements as required. Limit concentrations are specified in 22 CCR 66261.24 (*Ref. 3*). The Federal Toxicity Characteristic Leaching Procedure (TCLP) will be employed as required to determine specific RCRA toxicity characteristics.

Additional procedures, as called out in EPA SW-846, will be utilized as required for the waste stream characterization of specific metal analytes. For example, EPA SW-846 Method 3050 (Acid Digestion of Sediments, Sludges, and Soils) will be used for metal extraction, followed by analyses for mercury using EPA 7471 (Mercury in Liquid Waste, Manual Cold-Vapor Technique), arsenic using EPA 7060 (Arsenic - Atomic Absorption, Furnace Technique), and selenium using EPA 7740 (Selenium - Atomic Absorption, Furnace Technique). Specific analytes to be measured will be determined based on a review of the existing process knowledge for the generation of each individual waste stream.

Table 3
Non-Radiological Analysis Methods

Parameter	Analytical Method	Description
Ignitability (RCRA)	EPA 1010 EPA 1020	Pensky-Martens Closed-Cup Method for Determining Ignitability Setaflash Closed-Cup Method for Determining Ignitability
Reactivity (RCRA)	40 CFR 261.23	Characteristic of Reactivity properties
Corrosivity (RCRA)	EPA 9040	pH Electrometric Measurement
Toxicity Characteristic (RCRA)	STLC TTLC EPA 1311	Soluble Threshold Limit Concentration, using Waste Extraction Test Total Threshold Limit Concentration, using Waste Extraction Test Toxicity Characteristic Leaching Procedure (TCLP)
LDR Solvents (EPA Hazardous Waste No. F001-F005, RCRA)	STLC TTLC EPA 1311	Soluble Threshold Limit Concentration, using Waste Extraction Test Total Threshold Limit Concentration, using Waste Extraction Test Toxicity Characteristic Leaching Procedure (TCLP)
LDR Halogenated Organics (RCRA)	EPA 9020	Total Organic Halides (TOX)
Cyanides (RCRA)	EPA 9010 EPA 9012	Total and Amenable Cyanide Total and Amenable Cyanide (Colorimetric, Automated UV)
Sulfides (RCRA)	EPA 9030	Acid-Soluble and Acid-Insoluble Sulfides
Free Liquids	EPA 9095	Paint Filter Liquids Test
PCBs	EPA 8080	Organochlorine Pesticides and Polychlorinated Biphenyls by Gas Chromatography
pH	EPA 9045	Soil and Waste pH
Volatile Organics	EPA 8260	Volatile Organics by Gas Chromatography/Mass Spectrometry (GC/MS)
Semi-Volatile Organics	EPA 8270	Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry: Capillary Column Technique
Inorganics, Title 22 Metals	EPA 6010 EPA 7000	Inductively Coupled Plasma-Atomic Emission Spectroscopy Atomic Absorption Methods
TCLP Metals	STLC TTLC EPA 1311 EPA 6010 EPA 7000	Soluble Threshold Limit Concentration, using Waste Extraction Test Total Threshold Limit Concentration, using Waste Extraction Test Toxicity Characteristic Leaching Procedure (TCLP) Inductively Coupled Plasma-Atomic Emission Spectroscopy Atomic Absorption Methods

RCRA = Resource Conservation and Recovery Act
LDR = Land Disposal Restriction

Volatile organic contaminants will be extracted using TCLP zero headspace extraction (ZHE) and analyzed using EPA SW-846 Method 8260 (volatile organics) and EPA SW-846 Method 8270 (semi-volatile organics). Herbicides and pesticides will not be analyzed because there is no history of these chemicals in the SSFL D&D waste streams. As for metals, the selection of specific analytes for characterization will be determined based on a review of the existing process knowledge for the generation of each individual waste stream. SW-846 standard organic tests used for screening purposes are summarized in Table 4.

Table 4
Analysis Screening Methods for Organics

Technique	Method	Application
Gas Chromatography	EPA 8010	Halogenated volatile organics
	EPA 8015	Nonhalogenated volatile organics
	EPA 8020	Aromatic volatile organics
	EPA 8030	Acrolein and arylonitrile
	EPA 8040	Phenols
	EPA 8060	Phthalate esters
	EPA 8080	Organochlorine pesticides and PCBs
	EPA 8090	Nitroaromatics and cyclic ketones
	EPA 8120	Chlorinated hydrocarbons
	EPA 8140	Organophosphorus pesticides
	EPA 8150	Chlorinated herbicides
Gas Chromatography/ Mass Spectroscopy	EPA 8260	Volatile organic compounds
	EPA 8250	Semi-volatile organic compounds
	EPA 8270	Semi-volatile organic compounds
	EPA 8280	Polychlorinated dibenzo--p-dioxins and polychlorinated dibenzofurans

6.2 RADIOLOGICAL ANALYTES AND PROPERTIES

Individual radiological waste stream properties and analytes to be characterized either by process knowledge or laboratory analysis are summarized in Table 5, along with the analytical methods that will be employed where laboratory procedures are required.

Note that each test for both radiological and non-radiological characterization measurements has a sample volume or sample mass requirement. (Examples are given in Section 7.) If the contact radiation exposure rate for the sample specimen exceeds the acceptance limit for the analytical laboratory (10 mR/h is a typical value), an alternative approach will be addressed on a case-by-case basis. Options include the use of a smaller sample, if it can be shown that the smaller size will still produce defensible data, or a different procedure. If laboratory radiation exposure rate limits are exceeded for many of the analytical tests to be performed, waste stream characterization may have to be based primarily on process knowledge in accordance with the ALARA precept (Section 1.4) for waste handling.

Table 5
Radiological Analysis Methods

Radiological Property	Analysis Method
Gamma-ray emitters	High-resolution gamma spectroscopy
Nickel-63 (^{63}Ni), Iron-55 (^{55}Fe)	Chemical separation followed by low-energy gamma spectroscopy
Strontium-90 (^{90}Sr)	Chemical separation with ^{90}Y ingrowth
Uranium and transuranic isotopes: U, Th, Pu, Am	Chemical separation and alpha spectroscopy
Tritium (^{3}H)	Liquid scintillation counting (EPA Method 906)

7.0 SAMPLING PROCEDURE PREPARATION

An individual sampling procedure shall be prepared and approved for each waste stream prior to sampling. It shall include the following elements:

- A description of the waste, including references to process knowledge documentation.
- A detailed description of the number and locations of the samples to be collected.
- A list of the laboratory analyses to be performed and associated regulatory thresholds.
- A list of the sample containers required and post-collection sample handling requirements.
- A list of the equipment required to perform the sampling.
- Step-by-step operating procedures for sample collection.
- Quality control procedures to be used in the field.
- Sample identification and labeling instructions.
- Sample documentation and chain-of-custody procedures.
- Sample handling, packaging, and shipping instructions.
- Acceptance criteria against which the waste parameters are being evaluated

General requirements and guidance for the information to be included in the waste-specific procedures are presented below.

7.1 WASTE DESCRIPTION

The procedure must include a detailed description of the waste, including origin, handling, and storage (with numbers and descriptions of containers), plus references to the waste documentation. This documentation provides the traceable process knowledge information that is used to determine the sample analyses required to characterize the waste stream, and thus the sizes of the samples to be collected.

7.2 SAMPLES TO BE COLLECTED

The procedure shall include a detailed description of the numbers and specific locations of the samples to be collected, including controls and blanks. The identification of sampling locations shall be based on the sampling strategy presented in Section 5 of this SAP, and the method of sample selection shall be described in the procedure.

7.3 LABORATORY ANALYSES

The procedure shall include a list of all of the laboratory analyses to be performed on the collected samples, and the rationale behind each analysis procedure. The definition of the sample analysis tests to be performed shall be based on the analysis strategy presented in Section 6 of this SAP. This information is required prior to sample collection because it provides information on the required sample sizes and containers. A table of the regulatory thresholds to which the analysis results will be compared shall also be included.

7.4 SAMPLE CONTAINERS AND HANDLING REQUIREMENTS

The sampling procedure shall include a list of the sample containers required for collection of the samples in the field, and a description of their post-collection handling requirements. The container types and sizes, and the requirements for their handling between the times the samples are collected and analyzed, will vary from one analysis method to another. A summary of typical container and handling requirements for non-radiological analytical tests is provided in Table 6 for reference, and a container/handling requirements summary for radiological analyses is provided in Table 7.

Table 6
Reference Sample Container and Handling Requirements for Non-Radiological Analyses

Analytical Method	Analyte	Container Type	Volume Requirement	Preservative*	Maximum Holding Time
EPA 9045	pH	Widemouth glass with Teflon-lined cap	200 ml (4 oz)	None	Analyze immediately; 7 days for solids
EPA 8260	Volatile organics	Widemouth glass with Teflon-lined cap	200 ml (4 oz)	Cool to 4 ^{o}C	14 days
EPA 8270	Semi-volatile organics	Widemouth amber glass with Teflon-lined cap	1000 ml (8 oz)	Cool to 4 ^{o}C	14 days for extraction; 40 days for analysis
EPA 8080	PCBs	Widemouth amber glass with Teflon-lined cap	1000 ml (8 oz)	Cool to 4 ^{o}C	14 days for extraction; 40 days for analysis
EPA 6010/7000	Title 22 metals	Widemouth glass with Teflon-lined cap	500 ml (8 oz)	Cool to 4 ^{o}C	180 days (28 days for Hg)
EPA 1311/ 6010/7000	TCLP metals	Widemouth glass with Teflon-lined cap	500 ml (8 oz)	Cool to 4 ^{o}C	180 days (28 days for Hg)
PLM	Asbestos	Widemouth glass with Teflon-lined cap	500 ml (8 oz)	None	None
ASTM D-422	Particle size distribution	Widemouth glass with Teflon-lined cap	500 ml (8 oz)	None	None

* Only preservation required for soils, sludges, and sediments is to maintain at 4 ^{o}C.

Table 7
Reference Sample Container and Handling Requirements for Radiological Analyses

Analytical Method	Analyte	Container Type	Min. Sample Requirement	Preservative	Maximum Holding Time
High-resolution gamma spectrometry	Gamma emitters	Poly*	600 g	None	180 days
Chemical separation with ^{90}Y ingrowth	^{90}Sr	Poly*	600 g	None	180 days
Chemical separation and alpha spectrometry	U isotopes Th isotopes Pu isotopes Am isotopes	Poly*	600 g	None	180 days
Liquid scintillation (EPA 906)	^{3}H	Glass	100 ml	None	180 days

* Polypropylene or high-density polyethylene

7.5 SAMPLING EQUIPMENT

The sampling procedure shall include a list of all equipment expected to be required for the collection of samples in the field. This list shall include, but is not limited to, the following general equipment and material categories:

- Sample collection equipment, including sampling devices
- Tools for the removal and replacement of container closures
- Personal protective clothing
- Radiological survey instruments
- Radiological control materials (signs, rope, etc.)
- Accessory materials (plastic sheeting, pans, etc.) for material control during sampling
- Sample containers (as described below)
- Forms, labels, and seals for sample documentation and chain-of-custody control

7.6 DETAILED COLLECTION PROCEDURES

The procedure shall include detailed step-by-step instructions for sample collection, including the blank and control samples. Those instructions are to address the following areas:

- Preparation of a Controlled Work Permit

- Pre-sampling equipment and material assembly
- Personal protective clothing
- Pre-sampling safety verifications (equipment checks and emergency procedures)
- Preparation of staging area and work space
- Common problems and precautions/corrective actions in sample collection
- Decontamination of field equipment before and during the sample collection process
- Container identification
- Container opening
- Sample retrieval
- Placing samples in containers and labeling
- Collection of QA control samples (blanks and rinsates)
- Container resealing
- Sample documentation
- Disposition of investigation-derived wastes (unused samples, rinse waters, etc.)

Adherence to As Low As Reasonably Achievable (ALARA) objectives in field activities will be addressed as appropriate. Sample documentation shall include detailed entries on sampling operations in a field log book.

7.7 QUALITY CONTROL PROCEDURES

The sampling procedure shall identify the quality control procedures to be implemented during sample collection and handling prior to laboratory analysis. The objective of the QA procedures is to ensure that samples are collected and handled in such a manner as to maintain the integrity of the samples, preserve potential contaminants for analysis, avoid cross-contamination between samples, and avoid contamination from an outside source. The QA procedures also include the collection of duplicate samples whose analyses will provide a measure of the precision of the analytical methods. The field QA procedures are discussed in Section 4 of this SAP, and shall include the following:

- Preparation of trip blanks
- Preparation of field blanks
- Collection of final rinsates from equipment cleaning between samples
- Collection of duplicate samples

7.8 SAMPLE IDENTIFICATION AND LABELING

Each sample collected shall have a unique identification number and shall be clearly labeled. The sampling procedure shall provide the format for the assignment of those identification numbers and shall specify the labeling requirements for each sample container.

An example format for identification numbering, using the vacuum catch barrel debris waste stream as an example, is provided below:

Month-Day-Year/Source Building/Waste Stream Identifier/Sample Serial No.

e.g., **03-26-96/T020/VCBD-GEN/01**

where	**03-26-96**	=	sample collection date
	T020	=	waste stream source building (RIHL, Bldg. T020)
	VCBD-GEN	=	vacuum catch barrel debris - general
	01	=	sequential sample serial number

A sample label shall be affixed securely to each sample, completed in waterproof, non-smudging ink, and a tamper seal shall be affixed to each sample sent off-site for analysis. The format of the label and the tamper seal shall be identified in the sampling procedure; example formats are shown in Figure 4. Minimum information to be included on the sample label shall be (1) the sample identification number, (2) the date and time of sample collection, (3) the name of the collector, and (4) the place of collection (container and/or grid number). The seal should also include the sample number, date and time of collection, name of collector, and place of collection.

SAMPLE LABEL	
CLIENT:	SAMPLE #:
COLLECTION SITE:	DATE:
☐ GRAB ☐ COMPOSITE ☐ OTHER: ______	TIME:
ANALYSIS:	PRESERVATIVES:
	COLLECTED BY:

CUSTODY SEAL	SAMPLE ID: ______ COLLECTION SITE: ______ DATE: ______ TIME: ______ SIGNATURE: ______

Figure 4. Example Formats for the Sample Labels and Tamper Seals to Be Used on the Individual Sample Containers.

7.9 SAMPLE DOCUMENTATION AND CHAIN OF CUSTODY

The history and handling of each sample collected shall be documented from the time of its collection to the time of receipt at the analytical laboratory. Laboratory records will then document the sample custody from receipt at the laboratory through final analysis. Field and transit documentation procedures shall include the use of the field sampling logs, sample container labels, and chain-of-custody records. The sampling procedure shall specify the required documentation and the manner in which it is to be filled out.

The field sampling logs are detailed, numbered (archival) notebooks that are used to record all pertinent data on the collection of each sample. The notebook pages must be numbered and completed in permanent pen with errors crossed out by single lines, with each single-line cross-out initialed and dated. Each skipped page must have an “X,” the entry “left blank,” and the technician’s signature and date. The logs shall include the following field information:

- Date and time of entry (to agree with sampling date and time)
- Location and description of field site
- Container number and identification of material to be sampled
- Equipment used for sample recovery
- Description of sample (color, consistency, etc.)
- Sample handling activities (cutting, etc.) for transfer to the sample containers
- Sample identification numbers and analyses requested
- Sample collection sequence, including duplicates and rinsates
- Unusual concerns, such as container contents that were not as expected
- Names and signatures of persons collecting the samples and entering data into the logs
- Names and signatures of persons in physical possession of the samples

Chain of custody shall be established and documented by the use of a chain-of-custody form. This form must be established before shipment is made to an off-site analytical laboratory, and may be in a format supplied by the analytical laboratory in accordance with that laboratory’s Quality Assurance Management Plan. It documents the shipment of the samples from Boeing Canoga Park and their receipt by the analytical laboratory. An example format is shown in Appendix C.

7.10 SAMPLE HANDLING, PACKAGING, AND SHIPPING

The sample procedure must address sample handling to ensure that the integrity of the samples is maintained between the collection and analysis times, potential contaminants in the samples are preserved for analysis, and no outside contamination occurs. The inclusion of trip blanks (Section 4), the use of preservation procedures (Section 7.4), the application of tamper seals (Section 7.8), and the use of chain-of-custody forms (Section 7.9) are all intended to maintain and/or monitor sample integrity. In addition, packaging requirements to prepare the samples for storage and shipping must be addressed in the procedure, along with any special shipping instructions that require specific actions. Detailed shipping requirements are addressed in Boeing Canoga Park Procedure “Packaging and Shipment of Radioactive Waste (*Ref. 10*).

7.11 ACCEPTANCE CRITERIA

The acceptance criteria against which the waste characterization criteria are being evaluated shall be included in the sample procedure as an Appendix.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

The requirements for the evaluation and documentation of the field sampling characterization data are outlined below. This information shall be used to determine and document whether the waste meets disposal site acceptance criteria.

8.1 DATA REDUCTION AND EVALUATION

Data reduction is the process of converting the measurement data into a form that can be evaluated against the waste acceptance criteria. This includes the calculation of averages and standard deviations, and the performance of simple statistical tests to determine the confidence level of the calculated averages. Propagation of error shall be evaluated and considered when ascertaining usability of data for characterization of waste. These calculations must be performed using accepted statistical techniques. The method for calculating confidence intervals is given by Equation (4), Section 5.3. The results will be compared with the waste acceptance criteria to evaluate whether requirements are met for each measured analyte. Additional statistical calculations will be performed as required to further characterize the data, and calculated requirements for additional samples to meet the 90% confidence level, if appropriate, will be based on SW-846, as described in Section 5.3.

If one or more of the sample results equals or exceeds the acceptance criteria, an evaluation may be made to determine whether or not the contamination is localized with respect to container, time, or process of generation. If individual containers can be separated from a waste stream (with justification) for non-compliance with acceptance criteria, additional sampling may be performed for the remaining waste stream to re-evaluate compliance. Any waste stream determined to be heterogeneous in content, and thus not appropriate for characterization by true random sampling, will be further evaluated on a case-by-case basis. A waste stream found to exceed regulatory standards for hazardous waste (for any applicable analyte concentration) will be considered to be in non-compliance with LLW disposal site waste acceptance criteria and will be documented as prohibited from shipment to LLW sites for disposal.

8.2 DATA VALIDATION

Data validation will include a wide range of quality assurance functions that encompass the entire sample collection and analysis effort. Those quality assurance review activities required for the validation of each sample set analyzed are identified in Figure 5, the Sampling Data Summary Report. Figure 5 provides a recommended report format for summarizing the conclusions drawn from the results of the analysis set, and includes a check list to be used to verify that each required top-level data validation check has been performed.

Figure 5.

SAMPLING DATA SUMMARY REPORT

Waste Stream: ________________________________ ***Date(s) Sampled:*** __________

Purpose: ________________________________ ***EWR Number:*** __________

Analytical Laboratory: ______________________ ***Date of Last Validation:*** __________

Sample IDs: ______________________________

ANALYSIS CONCLUSIONS

Non-Radiological Analysis Summary (Conclusions on Presence of Hazardous Constituents): *(See analysis spreadsheet for measured analyte data, statistical analyses, and regulatory comparisons)*
Radiological Analysis Summary (Conclusions on Radionuclides Present): *(Including comparisons with historical data and expectations)*

Non-Radiological Analyst Signature: ____________________ ***Date:*** ____________

Radiological Analyst Signature: ________________________ ***Date:*** ____________

QUALITY ASSURANCE REVIEW

Sample Handling and Control: ☐ Proper field documentation of samples ☐ Complete Chain of Custody ☐ Proper sample labeling, handling, and preservation ☐ Sample hold times not exceeded	***Comments***
Completeness of Analytical Laboratory Data Reporting: ☐ Laboratory report signed and dated ☐ Case narrative included ☐ All requested analyses reported ☐ Duplicate analysis results reported ☐ Method detection limits reported ☐ Field (rinsate) and trip blank results reported ☐ Laboratory control and surrogate sample results reported ☐ Matrix spike and MS duplicate results reported	
Quality Assurance Validation of Analytical Results: ☐ Duplicate analysis results acceptable ☐ Field and trip blanks (where used) gave null results ☐ Method detection limits meet measurement requirements ☐ MS and control samples show process under control	
Data Usability: *(Do the Results Meet the Data Quality Objectives?)*	

Validator Signature: ____________________ ***Date:*** ____________

A more detailed data validation review will be performed on a periodic basis. That review will address the analytical laboratory quality control processes in detail. The results of these analyte-specific data validations will be documented in one or more Sampling Data Validation Reports, for which a recommended report format is shown in Figure 6.

The Sampling Data Validation Reports will require "Level 4" quality control data packages (which include laboratory QA/QC records and source data) from the analytical laboratory performing the analyses, and should be requested from the laboratory at the time the samples are submitted for analysis. Part of this data validation will be performed by a third-party reviewer. The Sampling Data Validation Report is a check sheet that includes a review of the third-party analysis, an evaluation against quality assurance objectives (QAOs, including PARCC and DQOs), and a comments section. It is to be supplemented with the third-party analysis report.

The detailed sample data validation review process shall be performed independently for each analytical laboratory used. It shall be performed for a minimum of 10% of the sample analysis sets sent to the laboratory, or on an annual basis if less than 10 sample sets are sent to the laboratory in a given year. For waste to be sent to NTS, the Level 4 third-party review process shall be performed for each new waste stream for which laboratory analyses are performed. The detailed data validation review shall include a separate validation for each analytical method employed, as identified on the Chain of Custody for that sample set. The detailed review shall cite the guidelines or procedures used to validate the data and shall include at a minimum: a general discussion of the data set, sample preparation and dilutions, initial and continuing calibrations, holding times, method blank analysis, laboratory control sample analysis, surrogate spike recoveries, data qualifier codes, and discussion on data quality. The completed validation report shall be submitted to NNSA/NSO as an attachment to the waste profile.

8.3 DATA REPORTING

The analytical laboratory shall provide a standard deliverable data package which contains Contract Laboratory Program (CLP)-level documentation that reports inorganic and organic analysis data, and CLP-like documentation for radiochemical analyses. More detailed analysis reports, detailing the laboratory QA/QC procedures, shall be requested from, and provided by, the analytical laboratory as needed to meet Boeing Canoga Park data validation requirements (Section 8.2).

Boeing Canoga Park will generate a summary report for the characterization of the waste stream that includes a summary of the data evaluation. A sample Sampling Data Summary Report is provided in Figure 5. One or more data validation reports may also be prepared, as described in Section 8.2. If none of the analyte concentrations of concern equal or exceed the disposal site acceptance criteria for those analytes, to a confidence level of 90% or greater, the sample set will be considered to provide an adequate demonstration that the waste stream represented by those analytical data are nonhazardous and acceptable for disposal at that site.

Figure 6.

SAMPLING DATA VALIDATION REPORT

Waste Stream: ________________________________ ***Date(s) Sampled:*** __________

Analytical Laboratory: ____________________________ ***EWR Number:*** __________

Analyte: ______________________ ***Sample IDs:*** ____________________________

Data Quality Objective (DQO): ____

INITIAL ANALYTE DATA CHECK

Initial Data Review to Confirm Measurements Under Control:

- ☐ Blank measurement values consistent with method detection limit (MDL)
- ☐ Field duplicates agree with primary samples within acceptable limits
- ☐ Matrix spike and matrix spike duplicate results yield expected results and agreement

REVIEW OF LABORATORY QUALITY CONTROL DATA PACKAGE

Third-Party Laboratory QC Data Package Review, Checked for Inclusion of the Following:

- ☐ Review of sample results
- ☐ Review of laboratory control and QC check samples
- ☐ Review of laboratory instrument calibrations, internal standards
- ☐ Review of laboratory raw data, analyte identification

☐ ***Third-Party Analysis Report Attached***

EVALUATION AGAINST QUALITY ASSURANCE OBJECTIVES (QAOs)

Precision: *(agreement between replicate samples)*

- ☐ Agreement between duplicate and primary samples is acceptable

Accuracy: *(nearness to true value)*

- ☐ Blanks give null analyte result
- ☐ Matrix spike and matrix spike duplicate meet laboratory control requirements
- ☐ Laboratory control and QC check samples meet control requirements (based on third-party review)

Representativeness: *(representative of entire waste stream)*

- ☐ Representative sample selection and collection (per sampling procedure)
- ☐ Sample preservation requirements were followed
- ☐ Field blank (rinsate), if used, gave null result
- ☐ Trip blank (for VOC samples) gave null result

Comparability: *(comparison with historical data plus interlaboratory comparisons)*

- ☐ Results agree with available historical data
- ☐ Analytical laboratory passed interlaboratory comparison performance programs

Completeness: *(amount of valid data compared to that specified)*

- ☐ Set of valid data (number of measurements) meets user sample requirement

Data Usability:

- ☐ Did analysis set meet analyte DQO?

Comments:

Validator Signature: ______________________ ***Date:*** ____________

REFERENCES

1. "Nevada Test Site Waste Acceptance Criteria," NTSWAC (DOE/NV-325), U. S. Department of Energy, Nevada Operations Office, Waste Management Division; some requirements derived from its predecessor, "Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements," NVO-325 (Rev. 1), U.S. Department of Energy Nevada Field Office and Reynolds Electrical & Engineering Co., Inc. Waste Management Department (June 1992)

2. P. H. Horton, "Application to Ship Radioactive Waste to the Nevada Test Site (NTS)," Rockwell International Rocketdyne Division Supporting Document N001ER000021

3. *California Code of Regulations*, "Title 22. Social Security," Barclays Law Publishers

4. D. R. Rochelle, "Quality Assurance Program Plan for ETEC Closure," Boeing Canoga Park Quality Assurance Program Plan QA-00001

5. "Radioactive Waste Management," DOE Order 435.1, U.S. Department of Energy, Office of Environmental Management

6. J. G. Barnes, "Procedures for Surveys of Radioactive Material Shipments," Boeing Canoga Park Radiation Safety Document RS-00011

7. *Code of Federal Regulations*, Title 40, "Protection of Environment," Office of the Federal Register National Archives and Records Administration

8. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, U.S. Environmental Protection Agency

9. *Code of Federal Regulations*, Title 49, "Transportation," Part 173, "Shippers - General Requirements for Shipments and Packagings," Office of the Federal Register National Archives and Records Administration

10. I. B. Bassat, "Packaging and Shipment of Radioactive Waste," Boeing Canoga Park Team Engineering Information Document EID-04482

APPENDIX A
ABBREVIATIONS AND ACRONYMS

ALARA	As Low as Reasonably Achievable
ASTM	American Society for Testing Materials
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
D&D	Decontamination and decommissioning
DOE	Department of Energy
DOE/NV	DOE Nevada Operations Office
DOT	Department of Transportation
DQO	Data Quality Objective
ETEC	Energy Technology Engineering Center
EPA	Environmental Protection Agency
LDR	Land Disposal Restriction
LLW	Low Level Waste
NIST	National Institute of Standards and Technology
NNSA/NSO	National Nuclear Security Administration/Nevada Site Office
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
NTSWAC	Nevada Test Site Waste Acceptance Criteria
PARCC	Precision, Accuracy, Representativeness, Comparability, & Completeness
PCB	Polychlorinated Biphenyl
QA	Quality Assurance
QA/QC	Quality Assessment/Quality Control
QAO	Quality Assurance Objective
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RIHL	Rockwell International Hot Laboratory
SAP	Sampling and Analysis Plan
SD	Start date (for waste stream sampling)
SHEA	Safety, Health, and Environmental Affairs
SSFL	Santa Susana Field Laboratory
STLC	Soluble Threshold Limit Concentration
SW-846	*Test Methods for Evaluating Solid Waste* (*Ref. 8*)
TCLP	Toxicity Characteristic Leaching Procedure
TRU	Transuranic
TTLC	Total Threshold Limit Concentration
WAC	Waste Acceptance Criteria
WET	Waste Extraction Test
ZHE	Zero Headspace Extraction

APPENDIX B

Values of *t* (90% Confidence Level)

Degrees of Freedom (df = number of samples-1)	$t_{0.20}$ (two-tailed test) $t_{0.10}$ (one-tailed test)
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.383
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
30	1.310
40	1.303
60	1.296
120	1.289
∞	1.2816

APPENDIX C

Example Field Chain-of-Custody Form

Sample Chain of Custody

Client Name ______________________ Sampler ______________

Phone # ______________________ Fax # ______________

Project Name / # ______________________

P.O. # ______________________

Sample Identification	Date Collected	Time Collected	Grab	Composite	Solid	Water	Oil	Specify:	Total of Containers	Analysis Required								Remarks

Sample relinquished by:	Date	Time	Sample received by:	Name of Shipper	Airbill No.	Date	Time
				Received by (Lab)	Date	Time	Seal Intact?

Turnaround Time Requested (please circle) : Normal Rush

Report Results by: (Date)______________________

Rush results requested by (please circle) : Phone Fax

Report Results to: ______________________

Sample Receiving Comments: ______________________

Cooler ID: ______
Cooler Temp: ______
Therm. ID: ______
Wet Ice / Blue Ice / None

Hand Delivered: ______
MSAI Courier: ______
Shipped: ______

Arrived in Shipping
Container: Y / N
Sealed: Y / N / NA

COC Seals on Container:
PRESENT ______
Intact ______
Broken ______
NOT PRESENT ______

Samples:
COC & Labels Match?
YES ______
NO ______

Broken / Leaking?
YES ______
NO ______

VOAs w/o headspace?
YES ______
NO ______

Preservative pH:
HNO_3: ______
H_2SO_4: ______
NaOH: ______
NaOH/ZnAC: ______

Correct Containers used?
YES ______
NO ______

Sufficient Quantity?
YES ______
NO ______